



American Finance Association

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Source: *The Journal of Finance*, Vol. 47, No. 4 (Sep., 1992), pp. 1623-1640

Published by: Blackwell Publishing for the American Finance Association

Stable URL: <http://www.jstor.org/stable/2328957>

Accessed: 25/11/2009 11:57

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Dividend Surprises Inferred from Option and Stock Prices

SASSON BAR-YOSEF and ODED H. SARIG*

ABSTRACT

This paper introduces a new method to measure the unexpected component of dividend announcements. While measures used previously were based on various arbitrary models of dividend expectations, our suggested method compares the reaction of stock and option prices to dividend announcements. Our measure is compared to commonly used model-based measures, to a Box-Jenkins time-series-based measure, and to a *Value-Line Investor Survey*-based measure of dividend surprises. The new measure is more highly correlated with the market's reaction to the announcements than are alternative measures of dividend surprises. The new measure is also shown to be insensitive to the extent to which the options used to identify unexpected dividend announcements are in- or out-of-the-money.

THEORETICAL ANALYSIS OF DIVIDEND policy has focused on the effect of dividends on stock prices and on optimal portfolio holdings.¹ Empirical tests of the theories are predicated upon their ability to identify the *unexpected* component of dividend announcements, or "dividend surprises." Since the market's dividend expectations are not directly observable, dividend surprises have been measured so far in relation to various *ad hoc* models of dividend expectations, such as the "Naive model," which assumes that investors expect dividend levels to remain the same from one quarter to the next. We propose to measure directly the magnitude of dividend surprises by using stock and option prices.

We will show that our price-based method is superior to model-based methods used in prior studies. For example, the stock market reaction to dividend announcements is more highly correlated with dividend surprises measured by our method than with dividend surprises measured by several model-based methods, including a method based on a Box-Jenkins estimation and on Value-Line's forecast of dividends. Additionally, the suggested price-based measure is shown to be insensitive to the choice of options used.

The paper is organized as follows. Section I examines a method, suggested by Cox and Rubinstein (1985) and by Garman (1983), for inferring dividend

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¹ See, for example, Bar-Yosef and Huffman (1986), Bhattacharya (1979), Brennan (1970), John and Williams (1985), Long (1977), Miller and Rock (1985), Ofer and Siegel (1987), and Talmor (1981).

expectations from observed stock and option prices. Our data are described in Section II. Section III demonstrates the inference procedure with an example, examines the sensitivity of the proposed measure with respect to the choice of options, estimates the informational value of dividends, and, finally, compares the incremental information content of the price-based and alternative measures of dividend surprises. Section IV is a short summary.

I. Extracting Dividend Expectations from Observed Option Prices

Option values are derived from the underlying stock value. Option holders, however, are not entitled to dividend payments. Hence, prior to a dividend announcement, option prices and stock prices differentially reflect the *expected* dividend payments. Immediately after the announcement, these prices differentially reflect the *announced* (i.e., actual) dividend payment. An examination of the relative change in option and stock prices following a dividend announcement allows us to identify the change in expectations, or the dividend surprise.

We infer dividend expectations using a method based on the relation between option and stock prices suggested by Cox and Rubinstein (1985) and by Garman (1983). This method has the advantage that it does not require knowledge of the underlying stock price process.

Garman (1983) shows that holding long one European call option, shorting one European put option (with the same exercise price), and investing the present value of the common exercise price in the risk-free asset is equivalent to holding a forward contract on the underlying stock. Since a forward contract on a stock is equivalent to holding the stock itself stripped of interim dividends, the following equilibrium relation holds:

$$PV(DIV) = S - (c - p + K*B_t), \quad (1)$$

where $PV(DIV)$ is the current value of expected interim dividends; S , c , and p are the prices of the underlying stock, the European call, and the European put, respectively; K is the common exercise price; and B_t is the time- t price of a pure discount bond maturing on the options' common expiration day. Note that equation (1) may be interpreted as the put-call parity relation for European options written on a dividend-paying stock.

Equation (1) is based on European option prices. Since we can only observe American options, we convert equation (1) to American prices. We define the American option over European option premium, for calls and puts, by:

$$\Delta c \equiv C - c \geq 0, \quad (2)$$

$$\Delta p \equiv P - p \geq 0, \quad (3)$$

where C and P are the American call and put prices, respectively. Equation (1) can now be written as:

$$IDIV \equiv PV(DIV) + (\Delta p - \Delta c) = S - C + P - K*B_t. \quad (4)$$

At first glance, equation (4) implies that the existence of an American-over-European premium impedes the use of American option prices for identifying dividend expectations. The price of an American option, however, is not divorced from the price of its European counterpart. (For example, Whaley (1982) found a mere half-percent difference between the prices of European and American types of call option.) Moreover, in some cases the prices of the two types of option are equal.² Hence, for empirical applications, equation (1) may be well approximated by equation (4), the equivalent relation for American options.

Furthermore, even if a significant premium exists, it need not affect our tests of the information content of dividend announcements. This is because our tests are based on a comparison of dividend expectations imputed from prices observed prior to and subsequent to the announcements (but always before the ex-dividend day).

Formally, we measure dividend surprises by subtracting dividend expectations imputed from pre-announcement option and stock prices from dividend expectations imputed from post-announcement prices. Let A denote prices observed after the dividend is announced, and B denote prices observed before the announcement. Using equation (4), our measure of dividend surprises, denoted by ΔDIV , is given by:

$$\Delta \text{DIV} = \text{PV}(\text{DIV})^A - \text{PV}(\text{DIV})^B + [(\Delta c^A - \Delta c^B) - (\Delta p^A - \Delta p^B)]. \quad (5)$$

Assuming that dividend announcements are anticipated (the null hypothesis of most of our tests), the bracketed term will be non-zero only if an *expected* announcement *differentially* affects the call and the put premia. It is an empirical question whether such effects take place, and whether they materially hamper our ability to identify dividend surprises in this manner. In Section III. *C* we report the results of diagnostic checks that suggest that changes over time in the American-over-European premium do not affect our tests.

In the following section we describe the data used and the specific steps taken in the identification of dividend surprises.

II. The Data

The data used in our study are compiled from four sources: CRSP, COMPUSTAT, *Value-Line Investor Survey*,³ and the *Berkeley Options Data*

² See, for example, Smith (1976): Prior to expiration, American call options will not be prematurely exercised whenever

$$\text{DIVIDEND} \leq K^*(1 - e^{-R(T-t)}),$$

where R is the forward rate between the dividend payout time, t , and the expiration date, T , as observed at time t , and K is the exercise price of the option. In these cases, the value of American calls will equal the value of otherwise identical European calls.

³ This Value-Line publication is issued periodically and encompasses a large number of corporations. It includes, inter alia, forecasts of various accounting numbers and of annual cash dividends. These forecasts are revised over the course of the year.

Base (BODB). We analyze data for the two years 1984 and 1985. Our final sample (after employing the selection criteria outlined below) consists of 174,000 simultaneous trades of stocks and options around 226 dividend announcements by 69 firms.

We start with 120 firms with options trading on their shares in 1984–1985. For each firm, regular dividend announcement dates are collected from the CRSP daily master tape and verified against the *Wall Street Journal Index*. Fifteen cases were removed from our sample because the CRSP and the *Wall Street Journal* dates did not match. Henceforth, the day a dividend announcement appeared on the *Wall Street Journal Index* is denoted as day 0.

Option and stock prices are collected from the BODB, which consolidates data derived from the *Market Data Report* of the Chicago Board Options Exchange, after filtering out suspect observations.⁴ We analyze trade prices from days -3 and -2 (relative to the announcement day, day 0) and from days 1 and 2. Option prices are included in our sample if they meet the following conditions:

- (1) The expiration date of the option is after the upcoming ex-dividend day and before the subsequent ex-dividend day,⁵
- (2) The price of the option is at least \$0.50; and
- (3) The bid-ask spread is less than 25% of the bid price.

The first condition assures that the options examined are entitled to a single dividend payment. The second and third conditions minimize the possible effect of discontinuous price quotes.

Since our calculation assumes simultaneous prices, the filtered prices are screened to include observations where a put and a call option with the same exercise price and expiration date trade within a time interval during which the stock price is constant (the BODB reports the constant-stock-price interval corresponding to each option trade). Last, each dividend announcement is checked to verify that enough data exist to estimate the dividend surprise. A dividend announcement is included if there are at least 10 simultaneous option trades prior to the announcement day and 10 simultaneous option trades after the announcement day.⁶

Implied dividend expectations are calculated with equation (4) from each triplet of simultaneously observed prices (i.e., simultaneously observed call, put, and stock prices). For each dividend announcement, we average dividend expectations imputed from price triplets observed before the announcement, $IDIV^B$, and dividend expectations imputed from price triplets observed after the announcement, $IDIV^A$. The difference between the two averages, $\Delta IDIV$,

⁴ A detailed description of the BODB and the filters employed in its creation can be found in Bhattacharya and Rubinstein (1978).

⁵ All firms in our study paid dividends regularly. Therefore, approximate future ex-dividend dates are known in advance.

⁶ Since the acquisition of a firm can effectively shorten the time to expiration of its options, the *Wall Street Journal Index* was also searched for 13D filings involving the firms subjected to our analysis. Two such cases were found and dropped from our sample.

is the calculated dividend surprise. When options with various exercise prices can be used for the calculation, $\Delta IDIV$ is estimated for each exercise price separately and the average of the separately estimated $\Delta IDIV$ s is used.

III. Empirical Results

A. An Example

A graphic example is provided to illustrate the price-based dividend-expectations extraction method. In Figures 1 and 2 we plot dividend expectations imputed from IBM share and option prices around the dividend announcement of the second quarter of 1984. Each point in the figures corresponds to an IDIV computation from a single observation of simultaneous trades in the stock, the call, and the put. Time in the figure is measured in seconds relative to the close of the market on the announcement day (excluding the seconds during which the market was closed).

IBM pays quarterly dividends with regular announcement and ex-dividend dates. In the first quarter of 1984 IBM reported higher earnings and the market expected a dividend hike (see, for example, *Wall Street Journal*, January 19, 1984: "... IBM's continued build-up of cash reserves makes a dividend increase likely ...").⁷ The announced dividend was \$0.95 per share, the same as the amount paid in the preceding quarter. The Naive model of dividend expectations, which has been extensively used in past empirical studies (see the precise definition below), would have classified this announcement as "fully anticipated." In fact, since analysts expected a dividend increase, the announced dividend was below expectations. By comparing the reaction of IBM's option and stock prices to the dividend announcement, we can observe the difference between the expected dividend and the announced one: in both figures there is a distinct drop in the implied dividend expectation following the announcement. Thus, the price-based inference method employed in this study identifies dividend surprises whether or not the actual dividend payment has been changed from the previous quarter.

Figures 1 and 2 illustrate the suggested method for measuring dividend surprises. Observe that implied dividends in Figure 1 are lower than in Figure 2, both prior to and following the dividend announcement date. This indicates that the American-over-European-option premium ($\Delta p - \Delta c$) was lower for the \$110 exercise-price options than for the \$120 options. The difference between the figures reflects the fact that for the \$110 options the call was in-the-money (both before and after the announcement) whereas for the \$120 options the put was in-the-money. It is important to note, however, that, despite the large difference in the levels of IDIV, the change in the implied dividends ($\Delta IDIV$) is virtually the same for both options. Section III. C reports test results indicating that $\Delta IDIV$ computations are indeed insensitive to the options used.

⁷ Giving similar reasons, Value-Line analysts also expected "a booster to the quarterly payout of about 15%" (*Value-Line Investor Survey*, 2/10/84).

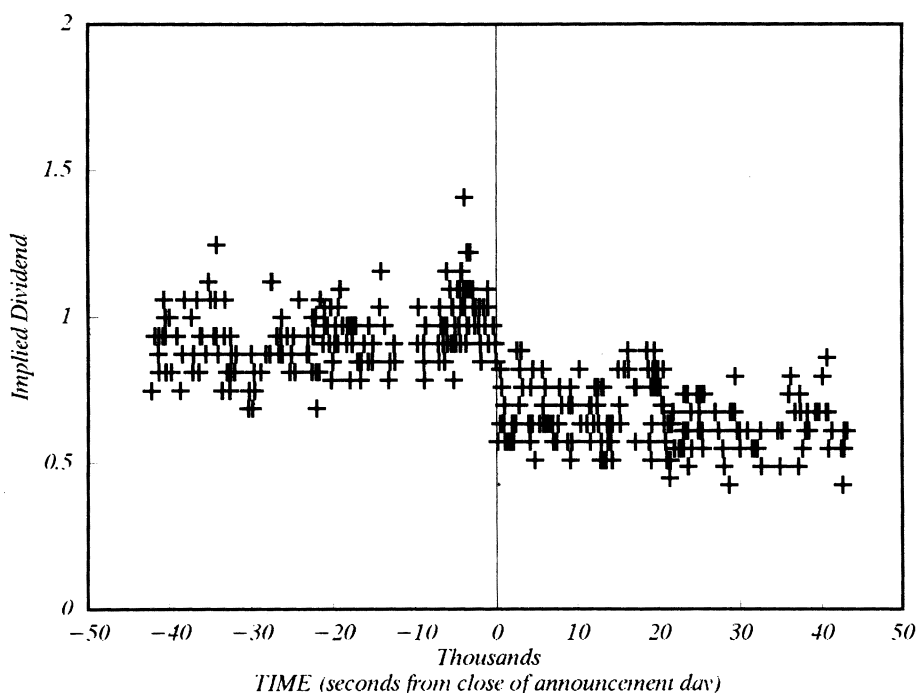


Figure 1. Dividend expectations for IBM in the second quarter of 1984 implied by IBM share prices and the prices of \$110-exercise-price options on IBM shares. Each point in the figure corresponds to a calculation of an implied dividend expectation from stock and option prices simultaneously observed at that time. Implied dividend expectations, IDIV, are calculated as: $IDIV = S - C + P - K \cdot B$, where S is the price of IBM stock, C is the price of the \$110 IBM call option, P is the price of the \$110 IBM put option, $K = 110$ is the options' exercise price, and B is the price of a T-bill maturing on the options' expiration day. Time is measured in seconds relative to the close of the market on April 30, 1984, the day IBM's dividend for the second quarter of 1984 was announced.

B. Alternative Measures of Dividend Surprises

We compare the price-based measure of dividend surprises to measures based on three expectation models and on the expectations of Value-Line analysts. The first model (the Naive model) assumes that the last regular quarterly dividend is the expected dividend payment. The Naive model is of special interest since previous empirical examinations of dividend policy predominantly employed this model of dividend expectations.

The second model (the Lintner model) is based on Lintner's (1956) study and on its empirical adaptation by Fama and Babiak (1968). Dividend expectations calculated according to this model are based on estimates of the dividend decision process as described by Lintner. Lintner argues that management's adjustment of dividend payments reflects the evolution of the

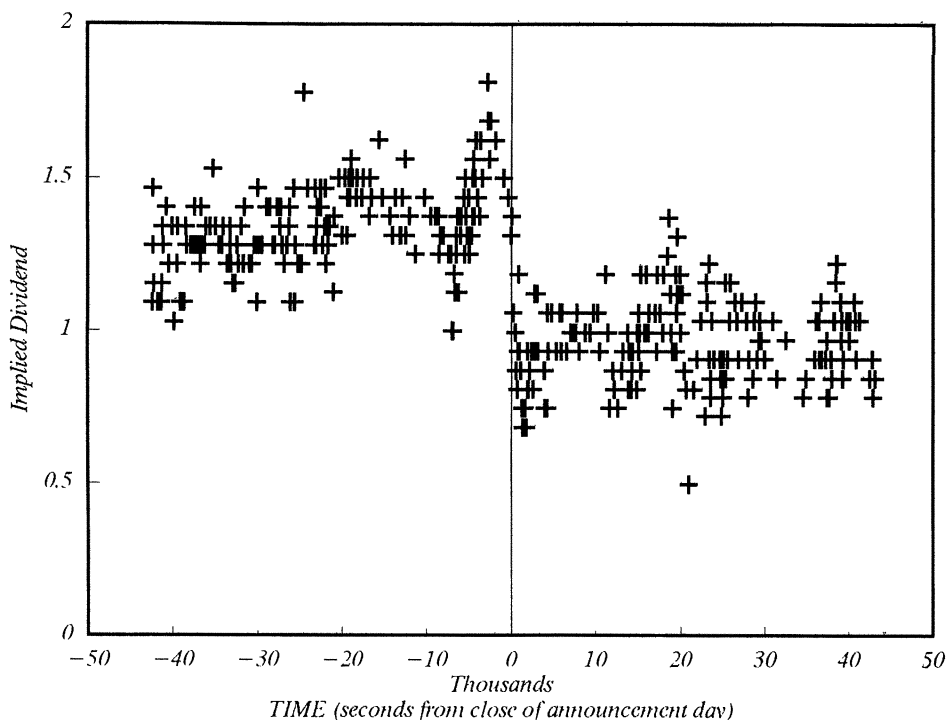


Figure 2. Dividend expectations for IBM in the second quarter of 1984 implied by IBM share prices and the prices of \$120-exercise-price options on IBM shares. Each point in the figure corresponds to a calculation of an implied dividend expectation from stock and option prices simultaneously observed at that time. Implied dividend expectations, IDIV, are calculated as: $IDIV \equiv S - C + P - K \cdot B$, where S is the price of IBM stock, C is the price of the \$120 IBM call option, P is the price of the \$120 IBM put option, $K = 120$ is the options' exercise price, and B is the price of a T-bill maturing on the options' expiration day. Time is measured in seconds relative to the close of the market on April 30, 1984, the day IBM's dividend for the second quarter of 1984 was announced.

firm's earnings. We employ the following version of this model:

$$E(D_t) = \alpha_0 D_{t-1} + \alpha_1 EPS_{t-1} + \alpha_2 EPS_{t-2} + \alpha_3 EPS_{t-3} + \alpha_4 EPS_{t-4},$$

where $E(D_j)$, D_j , and EPS_j are the firm's per-share expected dividend, actual dividend, and regular earnings in the j th quarter, respectively.

The third model (the Box model) is an application of Box-Jenkins methods to forecast the forthcoming dividend.⁸ Accordingly, for each dividend announcement, we identify the most parsimonious ARIMA model which produces "white noise" errors when fitted to the 30 quarterly dividend announce-

⁸ For a detailed description of these methods see Box and Jenkins (1976). We thank the referee for recommending the use of this model of dividend expectations. For other applications of Box-Jenkins methods to estimation of financial data see, for example, Foster (1986).

ments preceding the forecasted payment.⁹ This model is then estimated using a maximum-likelihood procedure. The estimated parameters are then applied to the most recent data to produce a forecast of the next dividend.

Last, we use Value-Line analysts' dividend forecasts as reported in the *Value-Line Investor Survey*. The expected quarterly dividend payment is calculated as the difference between annual dividends as forecasted just before the dividend announcement and the already-paid dividend amounts divided by the remaining number of dividend payments for that year. These expectations are denoted by VLN.

For each of these four measures of expected dividends, the estimates of dividend surprises are calculated as the difference between the dividends announced and the estimates of the expected dividend, denoted by ΔNAIVE , ΔLINT , ΔBOX , and ΔVLN , respectively. Table I provides descriptive statistics for these measures of dividend surprises.

Dividend changes are infrequent events. Accordingly, the Naive model classifies as surprising only 51 out of the 226 announcements. Additionally, as can be seen in Table I, the model-based measures of dividend surprises (i.e., ΔNAIVE , ΔLINT , and ΔBOX) have smaller standard deviations than the Value-Line-based or the price-based measures. This does not mean, however, that the Naive, the Lintner, or the Box models can "better" predict dividends than Value-Line analysts or the market. This is because a lower standard deviation corresponds to a better quality surprise measure only when the loss function for prediction errors is quadratic. The standard deviations of the surprise measures will be irrelevant if, for example, one does not care symmetrically about negative and positive dividend surprises (see, in this regard, the results of Aharony and Swary (1980)). Similarly, the standard deviations will be irrelevant if the cost of erring is not proportional to the square of the size of the error. (This cost could be, for example, constant for any error or proportional to the absolute size of the error.) Moreover, for some analyses other properties of the dividend surprise measures, such as their biases and correlations with other variables, may be important. In these respects, as we show below, the Value-Line-based and the price-based measures of dividend surprises have better properties than the model-based measures.

The summary statistics of the dividend surprise measures reported in Table I suggest that the price-based measure is most similar to the Value-Line-based measure, and that both are different from the model-based measures. So that the proximity of the various measures of dividend surprises may be farther examined, we present in Table II the correlation coefficients

⁹ The ARIMA models most frequently fitting the dividend history data are ARIMA (4, 1, 0), ARIMA (1, 0, 1), and ARIMA (4, 0, 1) in this order. Two cases were estimated with only 28 preceding dividend announcements because, in these cases, the firm did not exist in its current form in earlier quarters.

Table I

Summary Statistics of Dividends and Dividend Surprises

Summary statistics for 226 dividend announcements by 69 firms with options traded on their shares during 1984 and 1985. DIV denotes the actual dividend payment per share. ΔIDIV is the difference between dividend expectations implied by option prices observed before a dividend announcement and dividend expectations implied by option prices observed after the announcement. ΔNAIVE is the difference between the announced dividend and the previous regular dividend. It represents the surprise component of the dividend announcements assuming investors expect the quarterly dividends to remain at last quarter's level. According to this classification, there is 1 negative surprise, 50 positive surprises, and 175 no-surprise announcements. ΔLINT is the surprise component of dividend announcements assuming investors expect quarterly dividends to adjust according to the evolution of earnings. For firm i in quarter t , $\Delta\text{LINT}_{t,i}$ is calculated as:

$$\Delta\text{LINT}_{t,i} = \text{DIV}_{t,i} - \alpha_0 \text{DIV}_{t-1,i} - \alpha_1 \text{EPS}_{t-1,i} - \alpha_2 \text{EPS}_{t-2,i} - \alpha_3 \text{EPS}_{t-3,i} - \alpha_4 \text{EPS}_{t-4,i}$$

where $\text{DIV}_{s,i}$ is the dividend paid by firm i in quarter s , $s = t - 1, t$, and $\text{EPS}_{s,i}$ is the regular earnings per share reported by firm i for quarter s , $s = t - 4, \dots, t - 1$. α_0 through α_4 are estimated using data of the 4 years preceding quarter t . ΔBOX denotes the surprise component of dividend announcements assuming investors' expectations about the next quarterly dividend are formed by estimating an ARIMA (p, d, q) model which best fits the 30 quarterly dividends preceding the current quarter. ΔVLN is the surprise component of dividend announcements relative to the dividend expectations published in the *Value-Line Investor Survey* preceding the dividend announcement.

Variable	Mean	Standard Deviation	Lowest	First Quartile	Median	Third Quartile	Highest
DIV	0.4351	0.2782	0.0450	0.2500	0.3500	0.5762	1.2500
ΔIDIV	-0.0185	0.1653	-0.5941	-0.1245	-0.0234	0.0910	0.4789
ΔNAIVE	0.0111	0.0317	-0.1000	0.0000	0.0000	0.0000	0.2500
ΔLINT	0.0046	0.0426	-0.2420	-0.0857	0.0000	0.0127	0.1762
ΔBOX	0.0035	0.0629	-0.5218	-0.0042	-0.0002	0.0050	0.3597
ΔVLN	-0.0161	0.0784	-0.6200	-0.0166	0.0000	0.0000	0.2250

among the five measures of dividend expectations, and statistics about differences between them.

The Pearson and Rank correlations between any pair of measures of dividend expectations, reported in Panel A of Table II, are very high, ranging between 0.782 and 0.993, and are significantly different from zero at the 1% level. Average differences between the various measures of dividend expectations across the 226 cases are reported in Panel B of Table II. The t -statistics of the average differences indicate that the price-based measure and the Value-Line-based measure are similar to each other. These two measures, however, are significantly different from the model-based measures (with significance levels of 10% or less).

The individual measures also differ in their relation to the announced dividends. If investors' dividend expectations are rational, true dividend surprises will have a zero mean. Hence, if the dividend surprise measures are

Table II
Correlations and Average Differences Between Pairs of
Measures of Dividend Expectations

Correlations and average differences between pairs of measures of dividend expectations are estimated using 226 dividend announcements by 69 firms with options traded on their shares during 1984 and 1985. IDIV indicates dividend expectations implied by option prices observed before a dividend announcement. NAIVE represents dividend expectations calculated assuming that investors expect the quarterly dividends to remain at last quarter's level. LINT denotes dividend expectations calculated assuming that investors expect quarterly dividends to adjust according to the evolution of earnings. For firm i in quarter t , $LINT_{t,i}$ is calculated as:

$$LINT_{t,i} = \alpha_0 DIV_{t-1,i} + \alpha_1 EPS_{t-1,i} + \alpha_2 EPS_{t-2,i} + \alpha_3 EPS_{t-3,i} + \alpha_4 EPS_{t-4,i}$$

where $DIV_{t-1,i}$ is the dividend paid by firm i in quarter $t-1$ and $EPS_{s,i}$ is the regular earnings per share reported by firm i for quarter s , $s = t-4, \dots, t-1$. α_0 through α_4 are estimated using data of the 4 years preceding quarter t . BOX denotes dividend expectations calculated assuming that investors' expectations about the next quarterly dividend are formed by estimating an ARIMA (p, d, q) model which best fits the 30 quarterly dividends preceding the current quarter. VLN refers to dividend expectations published in the *Value-Line Investor Survey*. All correlation coefficients reported in Panel A of the table are significantly different from zero at the 1% level. Numbers in parentheses in Panel B of the table are t -statistics for the test that the average difference equals zero.

Panel A: Correlations Between Dividend Expectation Measures								
	Pearson Correlation Coefficients				Rank Correlation Coefficient			
	IDIV	NAIVE	LINT	BOX	IDIV	NAIVE	LINT	BOX
NAIVE	0.851				0.831			
LINT	0.852	0.993			0.828	0.993		
BOX	0.813	0.961	0.960		0.796	0.981	0.974	
VLN	0.782	0.964	0.948	0.945	0.802	0.983	0.978	0.982
Panel B: Average Differences Between Dividend Expectation Measures								
	IDIV	NAIVE	LINT	BOX				
NAIVE	−0.0006 (−2.478)							
LINT	−0.0005 (−2.133)	0.0001 (1.269)						
BOX	−0.0004 (−1.614)	0.0002 (2.441)	0.0001 (1.065)					
VLN	−0.0001 (−0.042)	0.0005 (4.841)	0.0004 (3.981)	0.0003 (2.822)				

unbiased proxies of the true surprises, these measures will also have a zero mean. However, the t -statistic testing the equality of the mean of the Naive measure of dividend surprises to zero is 5.336 (p -value less than 0.1%), suggesting that the Naive model produces a biased proxy of dividend surprises. The bias may be due to the Naive model's failure to account for an upward trend in dividends (the "reluctance to cut dividends"). On the other

hand, the corresponding t -statistic for the price-based measure is -1.561 (p -value 12.0%), indicating that dividend prediction errors measured from security prices appear to be unbiased.¹⁰

C. American Option Premia and Price-Based Measures

In Section I we suggested that the existence of an American-over-European-option premium should not affect the measurement of dividend surprises. The American-over-European-option premium (referred to, in this section, as “the premium”) depends on the characteristics of the option (see, for example, Roll (1977), Smith (1976), and Whaley (1982)). Hence, a test of the independence of calculated dividend surprises from the parameters of the options used is a test of the method’s insensitivity to the existence of the premium.

An important determinant of the premium is the extent to which the option is in- or out-of-the-money. (The difference between the IDIVs plotted in Figures 1 and 2 is a case in point.) Hence, we recalculate Δ IDIV using two nonoverlapping subsamples of observations. The first subsample consists of all simultaneous trades where the call is in-the-money, both before and after the announcement. We denote the Δ IDIVs calculated using this subsample by Δ IDIV-CALL. The second subsample consists of all simultaneous trades where the put is in-the-money. We denote the Δ IDIVs calculated using this subsample by Δ IDIV-PUT. Discarding simultaneous trades for which the traded option characteristics do not meet these restrictions reduces the number of dividend announcements for which Δ IDIV can be calculated to 127 and 168 announcements, respectively.

As can be seen in Panel A of Table III, the three measures of Δ IDIV have similar means and standard deviations. In columns 4 and 5 of Panel A we report pairwise comparisons of Δ IDIV calculations for all dividend announcements where Δ IDIV can be calculated for both subsamples. The mean difference between Δ IDIV calculations is less than one cent. The t -statistics (reported in parentheses) do not allow us to reject the null hypothesis of equal Δ IDIVs under commonly used confidence levels. This conclusion is further supported by the correlation coefficients among these measures, which are all high and significantly different from zero.¹¹

A further test of the insensitivity of Δ IDIV to the premium is based on the fact that an American call option will not be exercised before a dividend payment of size D if

$$D \leq K^*(1 - e^{-R(T-t)}), \quad (6)$$

¹⁰ The t -statistics for the LINT, BOX, and VLN measures are 1.959 (p -value 5.1%), 0.382 (p -value 70.3%), and -3.012 (p -value of 0.29%), respectively.

¹¹ Note that the correlation coefficients are between estimates of the unexpected portion of dividend announcements. The correlation coefficients between estimates of the dividend payments are all above 0.9.

Table III

The Relations Among Price-Based Measures of Dividend Surprises Calculated Using Various Sub-Sets of Options

The relations among price-based measures of dividend surprises, denoted by ΔIDIV , calculated for sub-sets of options, are estimated using 226 dividend announcements by 69 firms with options traded on their shares during 1984 and 1985. ΔIDIV is calculated as the difference between dividend expectations implied by option prices observed before a dividend announcement and dividend expectations implied by option prices observed after the announcement. N is the number of dividend announcements in each subsample. $\Delta\text{IDIV-ALL}$ denotes ΔIDIV s calculated using the entire sample. $\Delta\text{IDIV-PUT}$ refers to ΔIDIV s calculated using a subsample of options for which the put option is in-the-money, both before and after the dividend announcement. $\Delta\text{IDIV-CALL}$ refers to ΔIDIV s calculated using a subsample of options for which the call option is in-the-money, both before and after the dividend announcement. $\Delta\text{IDIV-SML}$ denotes ΔIDIV s calculated using a subsample of options which satisfy: $\text{DIVIDEND} \leq E^*(1 - e^{R(T-t)})$. Numbers in parentheses are t -statistics for the test that the mean difference is zero. All correlation coefficients reported in Panel A are significantly different from zero at the 1% level.

Panel A: ΔIDIV Calculated Using Options that Differ by the Relation Between Their Exercise Price and the Stock Price

	N	Mean	Standard Deviation	Mean Difference from a Matched Calculation of		Correlation Coefficient with a Matched Calculation of	
				$\Delta\text{IDIV-}$ CALL	$\Delta\text{IDIV-}$ PUT	$\Delta\text{IDIV-}$ CALL	$\Delta\text{IDIV-}$ PUT
$\Delta\text{IDIV-ALL}$	226	-0.0182	0.1656	-0.0032 (-0.328)	-0.0067 (-0.857)	0.809	0.836
				$N = 127$	$N = 168$		
$\Delta\text{IDIV-PUT}$	168	-0.0338	0.1852	0.0037 (0.173)		0.436	
				$N = 99$			
$\Delta\text{IDIV-CALL}$	127	-0.0311	0.1800				

Panel B: ΔIDIV Calculated Using Call Options Which are Not Expected to be Prematurely Exercised

	N	Mean	Standard Deviation
$\Delta\text{IDIV-SML}$	183	-0.0208	0.1616
$\Delta\text{IDIV-ALL}$	226	-0.0182	0.1656

where R is the interest rate between the ex-dividend day, t , and the option's expiration, T . (For a proof see, for example, Smith (1976).) We calculate another set of ΔIDIV s after eliminating all call options which do not satisfy condition (6). Panel B of Table III shows that the characteristics of ΔIDIV calculated after applying condition (6) are similar to the characteristics of ΔIDIV calculated without imposing this restriction. In 183 cases ΔIDIV can be calculated using option trades meeting restriction (6) and again using option trades not meeting the restriction. These two ΔIDIV measures have a

correlation coefficient of 0.980. The mean difference between matched pairs of these ΔIDIV calculations is 0.36 cents, which is insignificantly different from zero.

These results suggest that the American-over-European-option premium little affects the measurement of dividend surprises when the proposed method is used.

D. The Information Content of Dividends

Estimates of the information content of dividends are commonly derived from the observed market reaction to dividend announcements. In this section we estimate the relation between announcement-triggered abnormal returns and various measures of dividend surprises. We estimate abnormal stock returns on announcement days using the "market model":

$$E(r_i|r_{mt}) = \alpha_i + \beta_i r_{mt}, \quad (7)$$

where r_m is the equally weighted CRSP market index, and α_i and β_i are estimated from 120-day return data around the test period (days $-70, \dots, -11, 11, \dots, 70$). Abnormal returns in days -1 and 0 (where day 0 is the *Wall Street Journal* announcement day) are compared to the different measures of the unexpected changes in dividend yields. Specifically, we estimate the cross-sectional regression equation:¹²

$$AR_i = \alpha + \beta(\Delta D/\text{PRICE})_i, \quad (8)$$

where AR_i is firm i 's two-day abnormal return, ΔD is either firm i 's ΔIDIV , ΔNAIVE , ΔLINT , ΔBOX , or ΔVLN , and PRICE is the stock's price at the beginning of the calendar quarter during which the announcement was made.

Table IV shows that dividend surprises computed from market prices, ΔIDIV , are significantly related to the market's reaction to the announcements.¹³ The four alternative measures of dividend surprises are all insignificantly related to the market's reaction to the announcements.

Table IV also reports the rank correlation between abnormal returns and dividend surprises for the five measures. The less powerful nonparametric test allows us to test the relation between the market's reaction and the dividend surprise even when one does not accept the underlying assumptions of the regression analysis. The nonparametric test corroborates the results of the regression analysis.

The results reported in Table IV provide additional documentation of the information effect of dividend policy (see, for example, Aharony and Swary (1980)). Our results are based on a sample of large firms with options traded

¹² Note that of the 169 days in the two-year period studied, 125 days have only one announcement, 34 days have two announcements, 7 days have three announcements, and only 3 days have four simultaneous announcements. Therefore, we do not expect a significant cross-sectional dependence in our sample.

¹³ Since the unexpected component of dividend announcements is measured with error, the regression estimated is an "errors in variables" regression. Consequently, the estimated slope coefficients and the t -statistics are downward biased.

Table IV

Correlation Between Abnormal Stock Returns on Dividend Announcement Days and Unexpected Dividends

The correlations between abnormal stock returns, denoted by AR , and price-based measures of dividend surprises are estimated using 226 dividend announcements by 69 firms with options traded on their shares during 1984 and 1985. The regression statistics are for the regression $AR = \gamma_0 + \gamma_1[\Delta(\text{Div exp})/\text{PRICE}]$ where $\Delta(\text{Div exp})$ is either ΔIDIV , or ΔNAIVE , or ΔLINT , or ΔBOX , and PRICE is the price of the stock on the close of the preceding quarter. Daily abnormal stock returns are calculated as $AR_{it} = r_{it} - \beta_i r_{mt} - \tau_i$ where r_{it} is the return to the stock of firm i on day t , r_{mt} is the CRSP equally weighted index return on day t , and τ_i and β_i are firm i 's parameters estimated from return data during 120 days surrounding the test period (i.e., excluding the announcement day and 10 days around it). The dependent variable in the regression is the sum of the abnormal returns on the day the announcement was reported by the *Wall Street Journal* and on the preceding day. ΔIDIV is the surprise component of dividend announcements calculated by comparing dividend expectations implied by option prices observed before and after dividend announcements. ΔNAIVE is the surprise component of the dividend announcements calculated assuming that investors expect quarterly dividends to remain at last quarter's level. ΔLINT is the surprise component of dividend announcements assuming investors expect quarterly dividends to adjust according to the evolution of earnings. For firm i in quarter t , $\Delta\text{LINT}_{t,i}$ is calculated as:

$$\Delta\text{LINT}_{t,i} = \text{DIV}_{t,i} - \alpha_0 \text{DIV}_{t-1,i} - \alpha_1 \text{EPS}_{t-1,i} - \alpha_2 \text{EPS}_{t-2,i} - \alpha_3 \text{EPS}_{t-3,i} - \alpha_4 \text{EPS}_{t-4,i}$$

where $\text{DIV}_{s,i}$ is the dividend paid by firm i in quarter s , $s = t - 1, 1$, and $\text{EPS}_{s,i}$ is the regular earnings per share reported by firm i for quarter s , $s = t - 4, \dots, t - 1$. α_0 through α_4 are estimated using data of the 4 years preceding quarter t . ΔBOX is the surprise component of dividend announcements assuming investors expectations about the next quarterly dividend are formed by estimating an $\text{ARIMA}(p, d, q)$ model which best fits the 30 quarterly dividends preceding the current quarter. ΔVLN is the surprise component of dividend announcements relative to the dividend expectations published in the *Value-Line Investor Survey*. The rank correlations, ρ , are between the sum of the abnormal returns on the day the announcement was reported by the *Wall Street Journal* and on the preceding day (AR) and unexpected dividends ($\Delta\text{Div exp}/\text{PRICE}$).

Dividend Surprise Measure	Regression Results				Non-Parametric Results	
	Intercept	Slope	T-Statistic for Slope = 0	Adjusted R^2	Rank Correlation	Probability ($ \rho > 0$)
ΔIDIV	0.003	1.614	4.421	0.076	0.337	< 0.001
ΔNAIVE	0.002	1.958	0.840	-0.001	0.034	0.607
ΔLINT	0.002	0.299	1.350	-0.004	-0.019	0.779
ΔBOX	0.002	1.234	1.040	0.001	0.005	0.935
ΔVLN	0.002	1.358	1.359	0.004	0.061	0.359

on their shares. As large firms are typically closely followed by investors, expectations about their dividend policies are relatively accurate (see, for example, Gaver, Hwang, and Mayers (1990)). Thus, as Table IV shows, it is difficult to estimate the information effect of dividend policies of large firms using the less precise model-based proxies for investors' dividend expectations. By refining the estimation of dividend surprises, the price-based measure allows us to document the information effect of dividends, even for a sample of large firms.

Using a similar cross-sectional regression, we examine whether the way Δ IDIVs are calculated induces a spurious correlation with abnormal returns. Specifically, we calculate pseudo Δ IDIV by comparing dividend expectations implied by simultaneous trade prices on days other than those surrounding the announcement. In none of these estimates do we find a significant correlation between abnormal stock returns and the calculated pseudo Δ IDIVs. The correlation between abnormal returns and Δ IDIV on announcement days and the lack of correlation on other days suggest that identified dividend surprises are not due to spurious correlation. This further suggests that the method is robust with respect to changes in the American-over-European premium over time.

E. Incremental Information Content of the Price-Based Method

Using the magnitude of the market reaction to dividend announcements, we now compare the information embodied in the price-based measure of dividend surprises to the information embodied in the alternative measures. To perform this comparison, we regress two-day abnormal returns both on Δ IDIV and on the alternative measures of dividend surprises. Table V reports the results of these regressions. The first four regressions are pairwise comparisons of the relative information content of Δ IDIV and each of the alternative measures. The regression estimates indicate that the alternative surprise measures are unimportant incremental to the Δ IDIV measure. Moreover, even when *all* alternative measures are included in the regression equation (the fifth regression in Table V), Δ IDIV remains significantly related to abnormal returns.

The relative information content of the various measures of dividend surprises is also estimated without making the regression assumptions. We sort our sample of dividend announcements into three groups: positive, negative, and no surprises, according to the alternative measures. Within each group, announcements are sorted again into three subgroups, this time according to *our* measure of the surprise. For each subgroup we calculate the average two-day abnormal return. If the alternative measures are informational equivalent to our measure, the average two-day abnormal returns within each group should be the same for all subgroups. On the other hand, if our method yields a better measure of dividend surprises, the average abnormal return should differ across the subgroups according to the classification by our method. We apply the ANOVA procedure to test whether the average abnormal returns of the subgroups within each of the main groups are the same. The resulting *F*-statistics (with 4 and 219 degrees of freedom) are 5.24, 4.09, 6.09, and 2.24 for the Naive, Lintner, Box-Jenkins, and Value-Line measures, respectively. Hence, we can reject the hypothesis that the model-based measures are informationally equivalent to the price-based measure at the 99% confidence level, and that the Value-Line-based measure is informationally equivalent to the price-based measure at the 95% confidence level.

Table V

Multiple Regression of Abnormal Stock Returns Following Dividend Announcements on Alternative Measures of Dividend Surprises

OLS regression of abnormal stock returns, denoted by AR , following dividend announcements on alternative measures of dividend surprises, estimated using 226 dividend announcements by 69 firms with options traded on their shares during 1984 and 1985. The dependent variable is the sum of the abnormal returns on the day the announcement was reported in the *Wall Street Journal* and on the preceding day. The AR s are calculated as $AR_{it} = r_{it} - \beta_i r_{mt} - \gamma_i$ where r_{it} is the return to the stock of firm i on day t , r_{mt} is the CRSP equally weighted index return on day t , and γ_i and β_i are firm i 's parameters estimated from return data during 120 days surrounding the test period (i.e., excluding the announcement day and 10 days around it). The independent variables are $\Delta(\text{Div exp})/\text{PRICE}$ where $\Delta(\text{Div exp})$ is either ΔIDIV , or ΔNAIVE , or ΔLINT , or ΔBOX , and PRICE is the price of the stock on the close of the preceding quarter. ΔIDIV is the surprise component of dividend announcements calculated by comparing dividend expectations implied by option prices observed before and after dividend announcements. ΔNAIVE is the surprise component of the dividend announcements calculated assuming that investors expect quarterly dividends to remain at last quarter's level. ΔLINT is the surprise component of dividend announcements assuming investors expect quarterly dividends to adjust according to the evolution of earnings. For firm i in quarter t , $\Delta\text{LINT}_{t,i}$ is calculated as:

$$\Delta\text{LINT}_{t,i} = \text{DIV}_{t,i} - \alpha_0 \text{DIV}_{t-1,i} - \alpha_1 \text{EPS}_{t-1,i} - \alpha_2 \text{EPS}_{t-2,i} - \alpha_3 \text{EPS}_{t-3,i} - \alpha_4 \text{EPS}_{t-4,i}$$

where $\text{DIV}_{s,i}$ is the dividend paid by firm i in quarter s , $s = t - 1, 1$, and $\text{EPS}_{s,i}$ is the regular earnings per share reported by firm i for quarter s , $s = t - 4, \dots, t - 1$. α_0 through α_4 are estimated using data of the 4 years preceding quarter t . ΔBOX is the surprise component of dividend announcements assuming investors expectations about the next quarterly dividend are formed by estimating an ARIMA (p, d, q) model which best fits the 30 quarterly dividends preceding the current quarter. ΔVLN is the surprise component of dividend announcements relative to the dividend expectations published in the *Value-Line Investor Survey*. Numbers in parentheses are t -statistics for the test that the coefficients equal zero. F -values are for the significance of the regression as a whole. All F -statistics are significant at $p < 0.005$.

Intercept	ΔIDIV	ΔNAIVE	ΔLINT	ΔBOX	ΔVLN	Adj. R^2	F -Value
0.0031 (2.178)	1.6152 (4.324)	-0.0250 (-0.001)				0.072	9.731
0.0032 (2.385)	1.6500 (4.442)		-0.7230 (-0.549)			0.073	9.894
0.0030 (2.306)	1.5904 (4.326)			0.7147 (0.622)		0.074	9.941
0.0032 (2.397)	1.5731 (4.225)				0.5762 (0.587)	0.073	9.918
0.0032 (2.261)	1.5844 (4.137)	0.5281 (0.189)	-1.0640 (-0.693)	0.5810 (0.463)	0.6390 (0.615)	0.064	4.085

Using the same method, we test whether the alternative measures contain information not incorporated into the price-based measure of dividend surprises. The resulting F -statistics, testing equality of abnormal returns across the subgroups of the main groups formed on the basis of our method, do not allow us to reject the null hypothesis of "no incremental information" in the Naive, Lintner, Box-Jenkins, and Value-Line measures of dividend surprises.

These results suggest that the price-based measure of the dividend surprises incorporates more information than the model-based methods employed by previous studies.

IV. Conclusion

In this paper we propose and examine a new approach to identify and measure dividend surprises. We find that the proposed measure detects dividend surprises even when dividends remain constant. Furthermore, we find that the measure is insensitive to the extent to which the options used to measure dividend surprises are in- or out-of-the-money.

We also examine the relation between the proposed measure and the market's reaction to dividend announcements. In line with the findings of previous studies, our results indicate that unexpected dividend payments bring about a statistically significant market reaction. This shows that dividends have an information content even for closely monitored large corporations. When dividend surprises are measured according to alternative approaches, i.e., relative to the Naive, the Lintner, and the Box-Jenkins models, or the Value-Line dividend expectations, the mean two-day abnormal stock return following dividend announcements is less strongly correlated with the dividend surprises.

Last, we compare the five methods in terms of their ability to measure dividend surprises. We use the market's reaction to dividend announcements to gauge the extent to which each announcement is unexpected. The results indicate that the suggested method of measuring dividend surprises is more highly correlated with the true surprises than with dividend surprises as measured by either the Box-Jenkins method or by other models employed by past studies or in relation to Value-Line dividend expectations.

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